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City the moss flora of the north and of the south meet and mingle, and the number of species occurring is large, varied, and interesting."—J. M. C.

NOTES FOR STUDENTS

Transpiration studies.—Among several recent papers dealing with various phases of the study of transpiration, a prominent place should be given to one by LIVINGSTON and SHREVE[6] upon improvements in the use of the cobalt chloride paper method. An improved paper slip has been designed which combines two permanent color standards and an area of carefully prepared cobalt chloride paper. The determinations of the end points are made more definite, therefore, and the probability of error is much reduced. An improved device for furnishing a standard water surface is described also. The temperature relations of the rate of color change in the hygrometric paper and its permanent standardization is discussed also. These improvements will greatly advance the method of study which has already been proved valuable.

Another modification of methods of study is seen in DARWIN'S[7] investigation of the relation of transpiration to relative humidity by the porometer method, using *Prunus Laurocerasus* and eliminating the action of stomata by applying vaseline to the lower surface of the leaves and then placing their intercellular spaces in communication with the external air by means of incisions. Plotting the results, he found that transpiration varies directly as relative humidity when a correction is made for the fact that the transpiration rate is not zero in saturated air. The fact that transpiration does occur in saturated air is due, as pointed out by SACHS, to the production of heat in the leaf by respiration. The experiments showed that for the transpiration to be entirely checked a humidity of 5 per cent above saturation would be necessary, and hence the temperature of the leaf due to respiration is, under the conditions of the experiments, 0°8C. above that of the atmosphere.

Using similar methods and materials, DARWIN[8] also studied the effect of diffuse light upon transpiration. The results show so remarkable an amount of variation that it seems dangerous to draw any conclusions other than that light tends to increase the water loss for some unknown reason when its influence upon the action of stomata has been eliminated. This increase averages about 33 per cent.

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[6] LIVINGSTON, B. E., and SHREVE, EDITH B., Improvements in the method for determining the transpiring power of plant surfaces by hygrometric paper. Plant World **19**:257–309. 1916.

[7] DARWIN, F., On a method of studying transpiration. Proc. Roy. Soc. London B **87**:269–280. 1914.

[8] ———, The effect of light on the transpiration of leaves. Proc. Roy. Soc. London B **87**:281–299. 1914.

In a more recent report by the same investigator,[9] the corrections previously indicated for humidity and light are used in experiments designed to show the relation between the rate of transpiration and stomatal aperture, the latter condition being determined by the use of the porometer. There was also applied a further correction for cuticular transpiration. The final results show many irregularities, but are regarded by DARWIN as giving substantial support to his thesis that transpiration is regulated by stomatal aperture. He apparently finds nothing corresponding to the incipient drying of LIVINGSTON and BROWN, or the saturation deficit of RENNER, although it seems possible to the reviewer that some of his many irregularities might require some such explanation.

In striking contrast to this theory there comes an account of a study of water relations of cacti. On account of their peculiar behavior, these plants offer special advantages as well as special problems in the general study of transpiration. Their transpiring power differs from ordinary plants in being greater during the night than during the day. This behavior Mrs. SHREVE[10] has investigated, and has found that there is a regular diurnal march of change in the water-holding capacity of the internal tissues that seems both directly and indirectly responsible for the changes in transpiring power; that is, the transpiring power of the cactus is usually greater at night than during the day because the water-holding capacity of the tissues is greater by day than by night. The variations in water-holding capacity act upon transpiring power indirectly by closing the stomata, which in cacti are usually closed during the day and open at night, and they also act directly by resisting the evaporating power of the air. It seems possible, as the author of this paper points out, that a similar change in the tissues of non-succulents may account for the midday drop in their transpiring power.

BRIGGS and SHANTZ[11] have made an extensive and detailed study of transpiration as related to growth and to various climatic factors. The measurements were made at Akron, Colorado, during the seasons of 1914 and 1915 and were for 270 pots of 115 kgm. each of soil, including some 25 different crop plants. Continuous automatic records were obtained for air temperature, solar radiation, wet bulb depression, wind velocity, and evaporation from both shallow and deep tanks. Among the comparisons instituted, one of the most instructive is the correlation between transpiration for the small grains and various physical factors. This is expressed by mean correlation coefficients, some of which are those with evaporation from a shallow pan, 0.87; with wet bulb depression, 0.88; with temperature, 0.71; with radiation, 0.65; and with wind velocity, 0.22. These serve to emphasize the close relation of transpiration to humidity and evaporation and the comparatively slight influence of wind velocity.

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[9] DARWIN, F., On the relation between transpiration and stomatal aperture. Phil. Trans. Roy. Soc. London B **207**:413–437. 1916.

[10] SHREVE, EDITH B., An analysis of the causes of variation in the transpiring power of cacti. Physiol. Researches **2**:73–127. 1916.

[11] BRIGGS, L. J., and SHANTZ, H. L., Daily transpiration during the normal growth period and its correlation with the weather. Jour. Agric. Research **7**:155–212. 1916.

It is also interesting to note that during a 10-day period of maximum transpiration the daily loss of water ranged from 6 to 9 times the dry weight of the crop for millets and corn, from 12 to 16 times for the small grains, and up to 36 to 56 times for alfalfas. During the same 10-day period the annual crop plants lost about one-fourth of the total water transpired during the entire season. The transpiration of the different crop plants per unit area of plant surface shows less variation than the transpiration per unit of dry weight, hence the greater efficiency shown by certain plants in the use of water seems to be due more to a reduction in plant surface than to a reduction of transpiration per unit area of surface. Various other comparisons make this a valuable report for both the botanical and the agricultural investigator.

Another investigation undertaken with a view to economic application of results shows scientific merit of a high order and is comparable in methods and results with that just reviewed. In it KIESSELBACH[12] has limited his research to corn grown under conditions very closely approximating those of crop production. A portion of the experiments was devoted to the development of a satisfactory technique, and errors of former experimenters due to the use of immature plants and small quantities of soil were pointed out. It is impossible to summarize the many data, but it is interesting to note the agreement with the results of BRIGGS and SHANTZ in the very large proportion of total water used by the plant, which is lost during a comparatively short period of maximum transpiration. A rather surprising result is that it was found that corn plants grown for 2 months in a humid greenhouse exhibited no different transpiration rate per unit leaf area when transferred to dry conditions than took place from plants continuously grown under dry conditions. Further it appears that while there were considerable variations in the different varieties in regard to thickness of leaf and epidermis, and also in number of stomata per unit of leaf area, there was no consistent correlation between these structural features and the transpirational rate per unit of dry matter produced. In spite of this it was found that the water requirement of different varieties differed to a marked degree, suggesting that drought-resistant strains may be selected. It also developed as an important result of the investigation that water economy is greatest with neither an excessive nor a deficient soil moisture supply, and further that increasing fertility by the application of fertilizers resulted in still greater water economy.

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[12] KIESSELBACH, T. A., Transpiration as a factor in crop production. Research Bull. no. 7, Neb. Agric. Exp. Sta. pp. 214. *pls. 4. figs. 24.* 1916.

The relation of soil moisture to transpiration and to economy in the use of water is also shown by the investigations of YUNCKER,[13] who, using the wax seal method and weighing the sealed pots, has studied the comparative rates of transpiration of young plants of *Zea Mays* growing in soil with 3 different soil moisture contents, all somewhat above the wilting coefficient and showing respectively 25, 45, and 65 per cent of possible saturation. The rate of transpiration and the water requirement for periods up to 1320 hours was least for the driest cultures, which, however, seem to have had no deficiency in water supply, and most for those with the highest soil moisture content. Thus among other things it appears that the experiment demonstrated that the amount of dry matter formed was not at all proportional to transpiration.—GEO. D. FULLER.

Taxonomic notes.—LANGE,[14] in the second part of his studies on the agarics of Denmark, has published his results with *Amanita*, *Lepiota*, and *Coprinus*. The first part, published in 1914, contained a general introduction and an account of *Mycena*. The genus *Amanita* includes 14 Danish species; *Lepiota* 31 species, 1 of which is new; and *Coprinus* 33 species, 3 of which are new. The presentation of each genus is preceded by a full discussion of its characters and an analytical key.

MACBRIDE,[15] in presenting "The true Mertensias of western North America," recognizes 32 species, 4 of which are described as new. GRAY'S *Synoptical Flora* (1886) contains 7 species, 2 of which are restricted to the Atlantic states. Since that time, 74 species have been proposed. In a "Revision of the genus *Oreocarya*," 45 species are recognized, 4 of which are described as new. In "Notes on certain Borraginaceae," *Amblynotopsis* is proposed as a new genus (including 4 species transferred from *Krynitzkia*), and new species are also described in *Lappula* (2), *Cryptantha* (2), *Amsinckia*, *Mertensia*, and *Lithospermum*.

MOORE[16] has described 2 new genera: *Capitanopsis* (Labiatae) from Madagascar, and *Megalostylis* (Euphorbiaceae) from Peru or Brazil (upper Amazon region). He also describes 13 new species from Africa.

OKAMURA,[17] in his second contribution to the bryophytic flora of Japan, describes a new liverwort and 29 new species of mosses well distributed generically.

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[13] YUNCKER, T. G., A study of the relation of soil moisture to transpiration and photosynthesis in the corn plant. Plant World **20**:151–161. 1916.

[14] LANGE, JAKOB E., Studies in the agarics of Denmark. Part II. Dansk. Bot. Arkiv. **2**:no. 3. pp. 53. *pls. 2.* 1915.

[15] MACBRIDE, J. FRANCIS, Contrib. Gray Herb. no. 48, pp. 58. 1916.

[16] MOORE, SPENCER LEM., Alabastra diversa. XXVI. Jour. Botany **54**:249–257. 1916.

[17] OKAMURA, SHUTAI, Contributiones novae ad floram bryophyton Japonicam. Pars secunda. Jour. Coll. Sci. Tokyo **38**:no. 4. pp. 100. *figs. 42.* 1916.